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Society Science

Impact of Bioclogging on Peat versus Sand Biofilters

Although the bacteria in biofilter systems are critical to filtering and treating wastewater streams, their growth can also clog these systems, causing them to fail. A recent study in *Vadose Zone Journal* compared the impact of bacterial biomass growth on unsaturated, hydraulic conductivity and flow rate in biofilters composed of four media: filter media sand, septic bed sand, loose peat, and dense peat.

For each medium, five columns were constructed and tested. In the peat columns, saturation profiles measured over time showed an increase in water content over the entire column, suggesting that wastewater flowed easily through the peat and bacterial biomass developed over a wide range of depths. In the sand columns, in contrast, a pronounced increase in saturation was detected at the column top due to biomat formation.

Loading eventually had to be reduced from the initial 20 liters per week for all media. But loading had to be reduced soonest in the septic bed sand due to rapid formation of a biomat at the column's top, while the filter media sand took the longest to clog (39 weeks). The authors attribute these differences in saturation profiles and clogging times to differences in the nature and magnitude of each medium's pore sizes and the distribution of bacterial biomass within the columns.

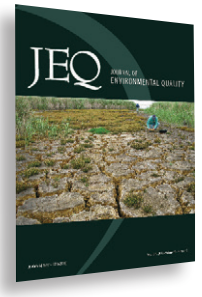
Overall, the peat media showed a slower reduction in peak outflows, indicating a lesser impact of microbial growth. The results validate the use of market-available peat filters for domestic use, though more research into mechanisms underlying bioclogging is needed.

Adapted from Mostafa, M., and P.J. Van Geel. 2015. Impact of bioclogging on peat vs. sand biofilters. Vadose Zone J. 14. View the full article online at http://dx.doi.org/doi:10.2136/vzj2014.07.0086

This paper is part of a VZJ special collection: "Organic Materials Used in Agriculture, Horticulture, Reconstructed Soils, and Filtering Applications."

doi:10.2134/csa2015-60-6-3

Nine-Year Effort to Reduce Nitrate Leaching



Leaching of nitrate from agricultural fields is of major concern in many countries. Several methods have been suggested for reducing nitrate leaching, such as non-inversion tillage, straw retention, and catch crops (cover crops). However, conflicting results are often reported, and there is a shortage of studies in which combinations of methods have been allowed to continue for several years.

In the May–June issue of the *Journal of Environmental Quality*, researchers report on nitrate leaching in a nine-year study that combined different tillage methods with different crop rotations, straw handling, and catch crops at two locations in Denmark, Northern Europe.

The researchers found that using a well-established fodder radish as a catch crop was the most effective method to reduce nitrate leaching under the region's prevailing temperate, coastal climate, because it reduced nitrate leaching to a very low level. The result is in agreement with Danish legislation, where catch crops are given high priority as a method to reduce nitrate leaching. In contrast, it was not possible to detect significant effects of non-inversion tillage or straw retention.

The two field experiments are also valuable for quantifying changes in crop growth, nitrate leaching, and, especially, carbon sequestration over time.

Adapted from Hansen, E.M., L.J. Munkholm, J.E. Olesen, and B. Melander. 2015. Nitrate leaching, yields and carbon sequestration after noninversion tillage, catch crops, and straw retention. J. Environ. Qual. 44(3): 868-881. View the full article online at http://dx.doi.org/doi:10.2134/jeq2014.11.0482

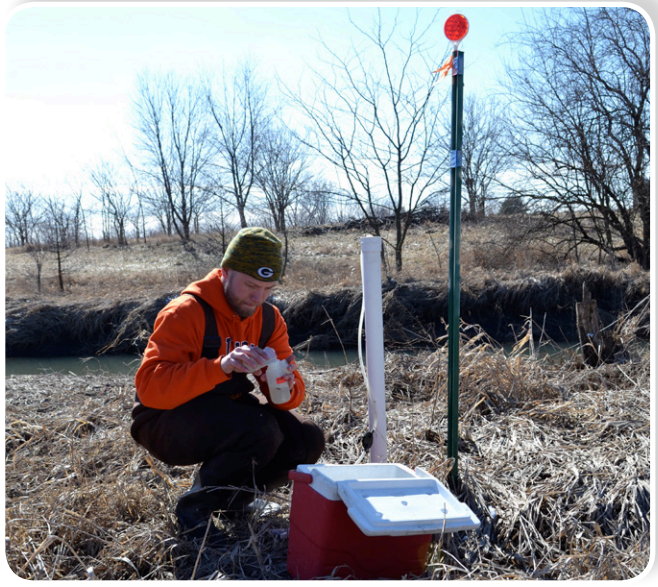
Fodder radish. *Photo by Elly M. Hansen, Aarhus University.*

Wetlands Remove Tile Nitrate with Little N_2O Emissions

Loss of nitrate from agricultural fields to surface waters leads to water quality problems, especially from areas that are extensively tile drained. To reduce these nitrate losses, a wide range of in-field and edge-of-field practices have been proposed, including constructed wetlands. In the May–June issue of the *Journal of Environmental Quality*, researchers re-evaluated constructed wetlands established nearly 20 years earlier for their current effectiveness in removing nitrate from tile drainage water. Along with this re-evaluation, they measured the production and flux of greenhouse gases: carbon dioxide, nitrous oxide, and methane.

The wetlands removed 56% of the total inlet nitrate load, likely through denitrification in the wetland. Additional removal of nitrate occurred in seepage water by the riparian buffer strip along each berm (6.1% of the inlet load, for a total nitrate removal of 62%). The dominant greenhouse gas emitted from the wetlands was carbon dioxide, with little methane. Nitrous oxide fluxes were between 3.7 and 13% of the total cumulative greenhouse gas flux, and were only ~2% of the total nitrate removed by the wetlands. Overall, these wetlands continue to effectively remove nitrate at rates similar to those measured following construction, with relatively little greenhouse gas loss.

Adapted from Groh, T.A., L.E. Gentry, and M.B. David. 2015. Nitrogen removal and greenhouse gas emissions from constructed wetlands receiving tile drainage water. J. Environ. Qual. 44(3): 1001-1010. View the full open access article online at http://dx.doi.org/doi:10.2134/jeq2014.10.0415



Lead author Tyler Groh sampling a groundwater monitoring well in the buffer strip near the Embarras River to determine nitrate removal of seepage water from the constructed wetland.

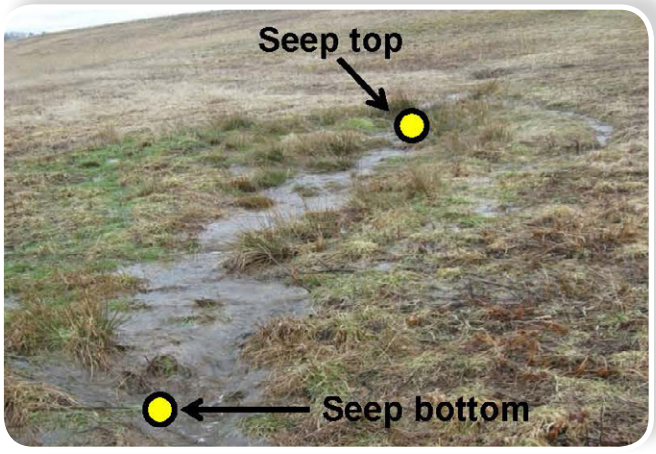
Effect of nitrogen management on seep and stream water quality

Riparian seepage zones are key hydrologic features in many Appalachian agricultural headwater watersheds. Seeps often supply most of the streamflow in these watersheds and connect nitrogen-rich groundwater systems to surface waters. Identifying factors that affect nitrogen losses from seeps to headwater streams is critical to developing sound management strategies for water quality protection. In a study in the May-June issue of the *Journal of Environmental Quality*, researchers from Penn State University and the USDA-ARS examined the impacts of land-applied nitrogen sources and in-seep nitrogen cycling on nitrate concentrations in seeps and streams of two small agricultural watersheds in central Pennsylvania.

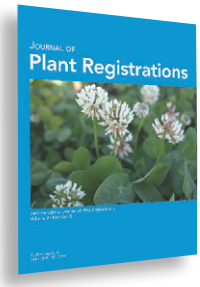
The authors found that spatially variable nitrogen applications to cropped fields upslope of the riparian zone were linked with nitrate concentrations in seeps. Seeps in both watersheds were able to retain or remove some nitrate (up to 37%) along their surface flow paths. But the overwhelming influence of land management on nitrate concentrations in seeps was still detectable at their point of confluence with the stream.

Findings from this study point to nitrate leaching from upslope farm fields as the primary driver of nitrate losses from seeps to streams in agricultural headwater watersheds. Thus, appropriate management strategies, such as cover crops, limiting fall/winter nutrient applications, and decision-support tools, should be targeted to these areas to reduce stream water nitrate levels.

Adapted from Williams, M.R., A.R. Buda, H.A. Elliott, A.S. Collick, C. Dell, and P.J.A. Kleinman. 2015. Linking nitrogen management, seep chemistry, and stream water quality in two agricultural headwater watersheds. J. Environ. Qual. 44(3):910–920. View the full article online at http://dx.doi.org/doi:10.2134/jeq2014.10.0412.



Riparian seepage zone at an agricultural headwater watershed in Pennsylvania.



Release of 'TAM 305', a Hard Winter Wheat with Superior Rust Resistance

It has become evident that wheat production must increase by 60% to meet global demands for food by 2050. Superior wheat cultivars with high yield potential, good end-use quality, and excellent and sustained disease resistance will play a major role in achieving this goal. Such genetic backgrounds are also sought for inclusion in crossing schemes to continue the incremental increase in yield potential.

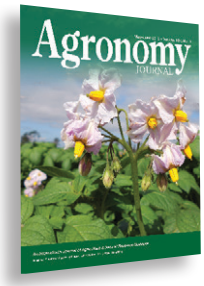
Texas plays a critical role in the spread of wheat leaf, stripe, and stem rust throughout much of North America, because it's one of the only states where these fungal pathogens overwinter. If not controlled, this reservoir of inoculum is carried north by wind as the season progresses, and can produce rust epidemics that negatively affect wheat production across much of the United States.

To address these concerns, the Texas A&M University breeding program has been aggressively developing wheat cultivars, with robust resistance to these rust types. One such cultivar is 'TAM 305', which is described in an upcoming issue of the *Journal of Plant Registrations*. These new cultivars also possess high yield potential, good adaptation, tolerance to heat stress, and good end-use quality characteristics.

Growing disease-susceptible wheat in Texas will only contribute to the buildup of rust inoculum, making it important to provide producers with superior cultivars that combine disease resistance with high yield potential and other valued traits. TAM 305 will also be useful for crossing schemes, providing a good parental background without impacting end-use quality and yield potential.

Adapted from Ibrahim, A.M.H., J. Rudd, R. Devkota, J. Baker, R. Sutton, B. Simoneaux et al. 2015. Registration of 'TAM 305' hard red winter wheat. J. Plant Reg. 9. View the full article online at http://dx.doi.org/doi:10.3198/jpr2014.08.0054crc

Texas A&M wheat breeders, Dr. Jackie Rudd (**left**) and Dr. Amir Ibrahim.



Study Shows Feasibility of Grass-Fed Beef Production

Winter pasture management is an important but not clearly understood component of beef production systems. In the May–June 2015 issue of *Agronomy Journal*, researchers compared four winter pasture management systems for spring-born steers that could sustain an average daily gain of 0.5 kg during fall and winter. The goal is to facilitate grass-fed finished animals in a 20-month production stream.

The systems included a naturalized grazingland, tall fescue pastureland, and two orchardgrass haylands. Grasses were stockpiled beginning in August and then grazed with a stocking density of 4.9 steers per ha from November through January. Hay or haylage was fed to steers until April, and pelleted soybean hulls were fed when gain fell below 0.5 kg per day.

The study found that grassland utilization was highest for fescue, at 1521 kg per ha. But dry weather during stockpiling also reduced the accumulation of fescue herbage. Differences in the grasslands' nutritive value were minimal, and no differences in gain were found between the systems. However, early and persistent snow cover in 2006-2007 and 2008-2009 led to the steers requiring supplementation.

The study demonstrates that yearling steers can be maintained during winter with a combination of stockpiled and conserved forages fed to achieve gains of 0.5 kg per ha per day. This suggests that Appalachian grasslands—the region's second-most predominant land use—are suited to grass-fed beef production.

Adapted from Mata-Padrino, D., Felton E., and Bryan, W.B. 2015. Winter management of yearling steers in a grass-fed beef production system. Agron. J. 107:1048–1054 View full article online at http://dx.doi.org/doi:10.2134/agronj13.0568

Tall fescue-based grassland in Appalachia (shown here in January) can help sustain expected average daily gain objectives for grass-fed steer finishing systems. *Photo by Domingo Mata*

Varying Nitrogen Rates in Terrain-Based Zones Not Profitable in Summer–Fallow System

Agricultural producers in the northern Plains of the United States can use variable-rate application technology to vary nitrogen (N) fertilizer within fields, but information on the economic feasibility of this practice is limited in this region. In the May-June issue of *Agronomy Journal*, researchers report on eight field studies conducted between 1994 and 2004 in northern Montana. A partial budget analysis was used to compare economic returns from uniform and variable N management on spring wheat in a summer-fallow system.

The team found that variable N management using conventional soil tests, fertilizer N recommendations, and terrain-based management zones was not more profitable than uniform N management. The reasons were traced to modest yield gains and N savings, nominal response to fertilizer N, and the inability to accurately define management zones and optimal N rates.

Variable N management may be a valuable approach for increasing N use efficiency and improving economic returns. However, varying N rates according to management zones based on an association between landscape position and soil water availability may not be useful for producers in semiarid landscapes of the northern Plains, particularly in dry years.

Adapted from Long, D.S., J.D. Whitmus, R.E. Engel, and G.W. Brester. 2015. Net returns from terrain-based variable-rate nitrogen management on dryland spring wheat in northern Montana. Agron. J. 107:1055–1067. View the full open access article online at http://dx.doi.org/doi:10.2134/agronj14.0331

Using a narrow-width air-till drill in a dryland spring wheat field near Malta, MN. Nitrogen fertilizer is applied in a series of incremental nitrogen rates to create replicated, parallel nitrogen strips across the field and enable the comparison of returns from uniform and variable nitrogen management.

Tillage and Rotation Effects on Corn Yields and Economic Return

Corn response to different tillage systems and crop rotations is highly influenced by soil conditions and weather variability. It's thus essential to consider these variables when adopting location-specific tillage systems and crop rotations. A recent study published in an upcoming issue of *Agronomy Journal* made agronomic and economic assessments of corn responses to different tillage and crop rotations across multiple soil and climate environments in Iowa.

Specifically, the researchers analyzed a dataset of corn yields and associated economic input costs for the first 10 years of data in an ongoing, long-term tillage and crop rotation study at seven Iowa locations. The goals were to examine the effect of seasonal variability, identify appropriate tillage and crop rotations, and evaluate the magnitude of each rotation's effect on corn yield.

The researchers found that regional soil and weather conditions affected corn yield and economic return, with corn-soybean (C-S) > corn-corn-soybean (C-C-S) > corn-corn (C-C). The yield penalty associated with C-C was location-specific and varied from 11 to 28%. Moreover, the input cost for corn production was greater with conventional tillage systems over no-tillage and strip-tillage by 7.5% and 5.7%, respectively. The scientists also found a gradient in yield and economic return across sites, with northern locations outperforming others by 1.9 Mg/ha and $330/ha.

The findings highlight the importance of variability in soil and climate conditions when considering different tillage systems and crops rotation to optimize yield, economic return, and environmental benefits. However, continuous corn production (C-C) regardless of tillage system can lead to significant declines in yield and return.

Adapted from Al-Kaisi, M.M., S. Archontoulis, D. Kwaw-Mensah, and F. Miguez. 2015. Tillage and crop rotation effects on corn agronomic and economic return at seven Iowa locations. Agron. J. 107. View the full article online at http://dx.doi.org/doi:10.2134/agronj14.0470

Soil moisture measurements at corn plots during the growing season at one of study sites in Iowa.

Cover Crop Water Use

Cover crops are being widely promoted because of soil health benefits. However, semi-arid dryland production systems, which are chronically short of water for crop production, may not be able to profitably withstand the yield reduction that follows cover crops because of cover crop water use. Some studies suggest cover crop mixtures should use far less water than single-species plantings, and that cover crop mixtures will use less water than is lost by evaporation from fallow, potentially improving the chance for successful cover crop use.

In the May-June issue of *Agronomy Journal*, researchers report on a two-year study from two central Great Plains locations where water use from single-species cover crop plantings was compared with water use from a 10-species mixture.

The team found that single-species plantings used the same amount of water as a 10-species mixture, and that cover crops grown in mixtures will use, on average, 1.8 times more water than is lost by evaporation from fallow. Thus, central Great Plains dryland farmers should be cautious when considering the use of cover crops in their farming operations as there is a high likelihood that subsequent crop yields will be decreased due to the cover crop water use, even when grown in mixtures.

Adapted from Nielsen, D.C., D.J. Lyon, G.W. Hergert, R.K. Higgins, F.J. Calderón, and M.F. Vigil. 2015. Cover crop mixtures do not use water differently than single-species plantings. Agron. J. 107:1025–1038. View the full article online at http://dx.doi.org/doi:10.2134/agronj14.0504

Breakeven Cost of Irrigating Grasses for Hay in Tennessee

In Tennessee, beef cattle is the largest agricultural commodity produced, accounting for $783 million in cash receipts in 2012. For most areas of the southeastern U.S. and Tennessee, beef cattle production depends on sustainable hay production to provide feed when forage available for grazing is limited. Tennessee and the southeastern U.S. can frequently experience short-term drought, resulting in beef cattle and hay producers expressing interest in using irrigation to provide supplemental water to mitigate production risk during the drought periods.

In a recent issue of *Agronomy Journal*, researchers report on a five-year study that was conducted for bermudagrass, tall fescue, and orchardgrass production in Tennessee. This study estimated yield response to three irrigation levels over three harvest periods using a mixed model and conducted economic analysis on the breakeven cost of irrigation applied for each grass production.

Orchardgrass and tall fescue hay yields negatively responded to irrigation during the spring harvest but positively responded to irrigation for the summer and fall harvests. Similarly, bermudagrass hay yield positively responded to irrigation during the summer and fall harvests. For all three grass species, hay yield was greatest at the highest irrigation level (3.05 cm week^{-1}) during the fall harvest only. The breakeven costs of irrigation for hay production ranged between $59 and $87 ha^{-1} for orchardgrass, $66 and $136 ha^{-1} for tall fescue, and $222 and $335 ha^{-1} for bermudagrass.

Results suggest a producer would be more likely to increase net returns by irrigating bermudagrass than irrigating cool-season grass species in the southeastern U.S.

Adapted from Zhou, X., C.N. Boyer, J.A. Larson, and B.G. Leib. 2014. Breakeven cost of irrigating bermudagrass, tall fescue, and orchardgrass hay production in Tennessee. Agron. J. 106:2227–2234. View the full article online at http://dx.doi.org/doi:10.2134/agronj14.0221

Soil Water Content Impacts Nitrate Anion Exclusion

Nitrate (NO_3^-) is the most widespread ground water contaminant found in agricultural settings. Additionally, where subsurface drainage practices are employed, NO_3^- from fertilizer applied to farm fields is often intercepted by buried drainage pipes and then discharged into local waterways. For most NO_3^- involved with aquifer contamination or degradation of surface waters via subsurface drainage discharge, initial transport is through the soil profile. A more complete understanding of processes affecting NO_3^- mobility in soil, particularly with respect to anion exclusion, is needed to better address NO_3^- environmental issues.

Due to anion exclusion, NO_3^- anions are repelled (excluded) near soil particle surfaces and then move at the fastest pore water velocities, thereby increasing soil NO_3^- mobility. In an upcoming issue of the *Soil Science Society of America Journal*, scientists report on a laboratory study, using a series of transient unsaturated soil column experiments, that evaluated soil water content impacts on NO_3^- anion exclusion. At the column inlet, where boundary conditions remained constant from start to completion of a test, the water content adjacent to the sides of the pores, where NO_3^- was excluded, ranged between 0.03 and 0.06 (12% to 19% of total water content) and increased with an increase in the overall soil water content (r = 0.60 and r = 0.67). These findings can be used to improve computer models for simulating soil NO_3^- transport, and in turn, better estimate the risk of NO_3^- release into the environment.

Adapted from Allred, B.J., G.O. Brown, and L.R. Martinez. 2015. Laboratory investigation of boundary condition impacts

on nitrate anion exclusion in an unsaturated soil. Soil Sci. Soc. Am. J. 79. View the full article online at http://dx.doi.org/doi:10.2136/sssaj2014.09.0388

Anthropogenic and Cimatic Controls on India Soil Organic Carbon Stocks

Soil organic carbon (SOC) is an important indicator of soil quality that affects ecosystem functioning and food security, and even small changes in SOC stocks could have substantial consequences for global carbon cycling and feedback to climate system. In India, home to nearly 20% of the world's population, how multiple global change factors control SOC dynamics is relatively unexplored. Supported by the NASA Land Cover and Land Use Change Program, a research team has now made the first attempt to quantify multiple environmental controls on SOC stocks in India. To do so, they used a well-established, process-based model—the Dynamic Land Ecosystem Model (DLEM)—driven by century-long land-use history and verified by intensive field observations.

The study, published in an upcoming issue of the *Soil Science Society of America Journal*, revealed that the SOC stock in India increased by 3 Pg C from 1901-2010, mainly as a result of elevated CO_2 concentrations, increasing nitrogen deposition, cropland expansion, and implementation of agricultural management practices such as fertilizer use and irrigation. However, climate warming, frequent drought, and tropospheric ozone pollution have also negatively affected Indian SOC stocks.

These findings demonstrate that SOC dynamics in India have been significantly altered by anthropogenic activities through climate change, air pollution, and land cover and land use changes. The authors suggest that an integrated ecosystem model for quantifying SOC changes in response to multiple environmental factors would provide a scientific basis for assessing climate impacts, land management options, and climate adaptation and mitigation strategies at broad scales.

Adapted from Banger, K., H. Tian, B. Tao, C. Lu, W. Ren, and J. Yang. 2015. Magnitude, spatiotemporal patterns, and controls for soil organic carbon stocks in India during 1901–2010. Soil Soc. Sci. Am. J. 79. View the full article online at http://dx.doi.org/doi:10.2136/sssaj2014.11.0456

Dominant Invasive Plants Can Have Minor Ecosystem Effects

Invasive species have often been documented to have widespread ecosystem effects, but the magnitude and direction of these effects are difficult to predict. It is essential to know under what circumstances the invasion of a new species into a habitat will significantly alter ecosystem function, and the importance of these species-level effects versus other environmental drivers.

In a recent study in the *Soil Science Society of America Journal*, researchers found that reed canary grass (*Phalaris arundinacea*)—widely recognized as a problematic invasive plant—had relatively minor effects on a broad suite of ecosystem functions related to carbon and nutrient cycling in an Oregon freshwater marsh after several decades of establishment. The relatively small effects of reed canary grass in this wetland resulted from its displacement of a native sedge with similar traits. In addition, the researchers found that plant species identity was secondary to seasonal controls over ecosystem dynamics.

This study shows that predicting the effects of an invasive plant on ecosystem dynamics will depend on the functional characteristics of the resident community being invaded.

Adapted from Turnbull, L.C., and S.D. Bridgham. 2015. Do two graminoids, the invasive Phalaris arundinacea, *and the native* Scirpus microcarpus *have similar ecosystem effects in a wetland? Soil Sci. Soc. Am. J. View the full article online at http://dx.doi.org/doi:10.2136/sssaj2014.08.0335*